

Extension briefs for

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(Citrus Research International)

Integrated pest management

(T.G. Grout, S.D. Moore and
A. Manrakhan)

Phytosanitary pests

All the recommendations made in the Extension Briefs for February and March also apply to this period. Control of insect pests of phytosanitary concern is critical.

At least once a week, growers must conduct sanitation of split, stung or infested fruit in the trees, or fallen fruit on the ground. According to the pre-harvest fruit infestation monitoring protocol, growers should also continue to monitor infestation of fallen fruit every second week. This is a mandatory practice for the last 12 weeks before harvest, for participation in the FCM Risk Management System (FMS). Once the required information has been entered, PhytClean will report the calculated FCM infestation per tree per week, as well as whether the threshold has been surpassed or not. Regardless, a final spray for FCM is recommended a minimum of four weeks before harvest, using a product with a pre-harvest interval, which is within that time.

Fruit fly control initiated in mid-summer should continue regularly and be adjusted according to trap catches. If trap thresholds are exceeded, control actions must be increased. Control actions for fruit flies include the use of registered protein bait sprays and/or bait stations and orchard sanitation. Where Oriental fruit fly (OFF) is present, growers should also apply registered methyl eugenol-based Male Annihilation Technique (MAT) (e.g. Invader-b-Lok, a block impregnated with Chempac ME lure and malathion, or Static Spinosad ME).

During harvesting, pre-sorting of any potentially infested fruit must be conducted in the orchard. Under the FMS and FFMS for citrus – other than lemons and limes – packhouses must conduct inspections for FCM and fruit fly infestation on samples from all orchards, on delivery to the packhouse, using trained inspectors. On the pack line, all fruit with blemishes that could be associated with FCM or fruit fly must be graded out. Sorting tables must be very well lit to facilitate optimal sorting. As with packhouse delivery inspections, only trained and competency-evaluated personnel may conduct this sorting and grading process.

Fruit must be thoroughly and regularly inspected for mealybug infestation both pre- and postharvest, as described in Cutting Edge no. 298. It is also important to determine the species of mealybug present, in order to avoid export of fruit infested with phytosanitary species to sensitive markets. Note that colour plates and a key for identification of the different mealybug species are available to order from CRI. If necessary, please also bear in mind the molecular identification service offered by the CRI diagnostic laboratory in Nelspruit and the Department of Agriculture, Land Reform and Rural Development (DALRRD) Plant Health Diagnostic Laboratory in Stellenbosch.

Blemish factor analysis

The analysis of fruit blemish factors on the tree just prior to harvest or once fruit has been harvested, provides the grower with an evaluation (in commercial terms) of all control programmes implemented during the season. It also assists with pest management decisions for the season to

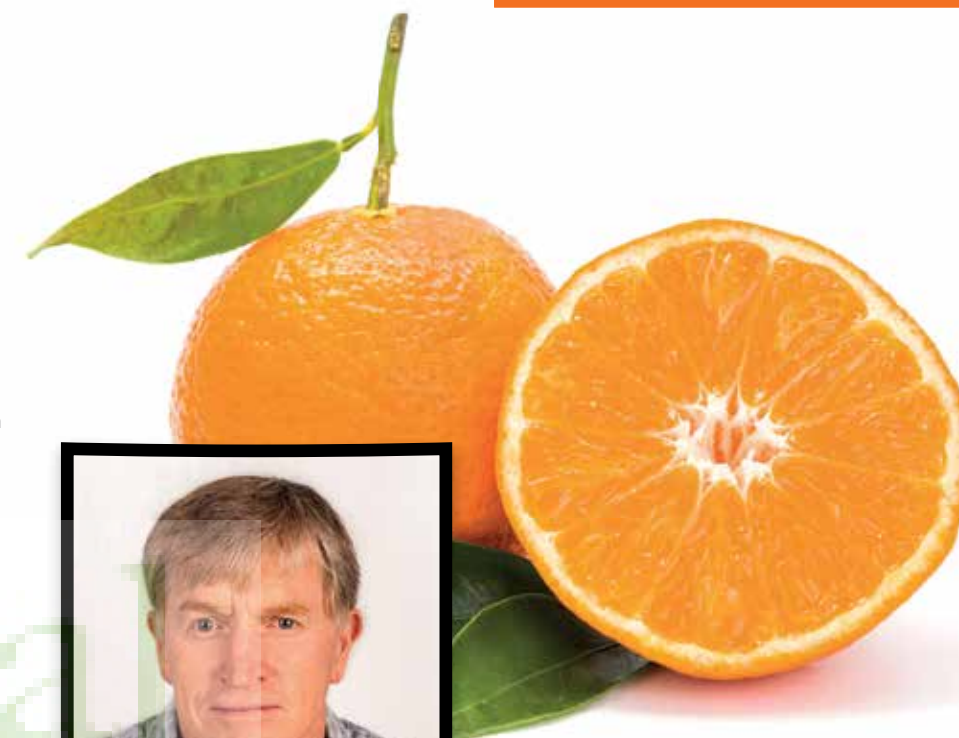
follow. The importance of this practice is increasing, with growing pressure from markets for IPM implementation and reduction in chemical residues. This data collected can enable one to make an educated decision on whether spraying for a particular pest is unnecessary or not, thus reducing input costs.

With the trend towards selective picking and a variable degree of culling occurring in the orchard, it is more accurate to conduct the final analysis of fruit blemish factors before picking starts. Care must be taken to include fruit from inside the tree and all blemish factors or pest infestations should be recorded, whether they are sufficient to cull the fruit from export quality or not. Having taken the sample, it is important to record separately each pest or other blemish factor that is severe enough to downgrade a fruit in its own right. With this procedure, a particular fruit in the sample may be shown to have more than one factor that can cause it to be culled from export.

Crop and fruit quality management (P.J.R Cronjé)

General: Stage II of fruit development is ending, with stage III commencing with little or no increase in fruit size as the fruit matures, i.e. increase in juice content, total soluble solids (Brix°) and reduction of titratable acidity (TA). Lower autumn temperatures will affect rind colour but GA₃ (Progibb®) and Nitrogen applications later than five months prior to harvest would have resulted in retarded colour development.

Maturity indexing: Commence maturity indexing on early and mid-season cultivars in order to harvest at optimal maturity and facilitate an adequate shelf life. Weekly samples from 10 representative trees should start four to six weeks before the expected harvest date. Titratable acidity is determined by titration with sodium hydroxide, sugar content (Brix°) is determined by a refractometer, and the fruit colour and sugar to acid ratio calculated should be read from



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protocols during picking and handling of fruit. Picking bags should always be carried on the side of the waist to avoid crushing of fruit between the body and the ladders, bins or trees. Picking bags must be free of leaves, shoots or sand and kept dry throughout. To avoid lesions on fruit, fingernails of pickers should be short and clippers and ladders handled correctly, i.e. no long stems, and there must be limited contact between ladders and fruit. Low-hanging fruit very close to the ground/touching the ground, or dropped fruit should be removed a day or two prior to harvesting an orchard, to lower the risk of sour rot and brown rot development in export cartons. At each bin, sorters wearing gloves should be stationed to monitor fruit quality.

Pruning of early cultivars (Satsuma and Clementine) should be done during this period, as soon as possible after harvest. Prune more heavily after a light crop and if a heavy crop is expected, and when the orchard has a history of alternate bearing. Old twigs and dead shoots should also be removed to limit wind damage of the next season's crop. Pruning should be effective to ensure sufficient light distribution and spray penetration into the centre of the canopy.

a colour chart. Results should be recorded and used in comparison with previous seasons in order to identify and manipulate possible problems with internal and external quality parameters.

Pickers' training and monitoring:

Training of pickers is important and the workers should be familiarised with important

Postharvest foliar urea application: A foliar application (low biuret urea at 1%) can be applied on early cultivars (Satsuma and Clementine) as soon after harvest as possible.

Citrus black spot disease management (P. Moyo and P.H. Fourie)

General: At this stage, most growers should have completed all their scheduled pre-harvest sprays for citrus black spot (CBS). Since CBS symptoms only appear on mature fruit, absence of pre-harvest symptoms is not necessarily indicative of successful CBS control. It is advisable to assess the CBS risk of orchards to exclude export from high-risk orchards to CBS sensitive markets. Here are some suggested criteria that can be used:

- **CBS history of orchard:** older orchards tend to have more CBS, but various factors (including cultivar susceptibility, topography, orchard condition, canopy density and efficacy of spray deposition) can influence the disease pressure. If monitoring records were kept, growers will be able to identify orchards with a higher CBS incidence. Orchards where CBS disease incidence was high in the previous two seasons can be expected to have a higher inoculum pressure in the past season.
- **Inoculum management:** monthly removal of all fallen leaves from late winter through the fruit susceptibility period has been shown to be as effective as full CBS spray programmes. Conversely, pruning debris that is left in the orchard will contribute to the inoculum pressure. It is unclear to what extent shredding of pruning debris will limit ascospore production on leaves, but growers are advised to at least shred their pruning to a very fine particle size (< 5 cm²); the smaller, the better. Likewise, removal of all out-of-season fruit is important to limit pycnidiospore inoculum.
- **Prevailing weather conditions:** the CBS



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pathogen can only infect fruit if warm and wet conditions are experienced during the fruit susceptibility period (four to five months after fruit set). A comparison of suitability of weather conditions for CBS experienced in the past season with previous seasons will be indicative of the relative risk. Growers are also encouraged to register on CRI-PhytRisk (www.cri-phytrisk.co.za) to compare the CBS infection forecasts for the season with the spray programme that they followed. If all infection periods were protected, the CBS risk should be lower, assuming that sprays were effectively applied during weather conditions suitable for spraying (this can also be observed from CRI-PhytRisk), and effective fungicide coverage and deposition was achieved.

Grondgedraagde siektes (M.C. Pretorius en J. van Niekerk)

Phytophthora- en aalwurmbeheer

Winterreënvalgebiede soos die Wes-Kaap moet nou *Phytophthora*- en aalwurm-ontledings laat doen. Beheerprogramme moet ná die eerste goeie winterreëns begin. Beheermaatreëls moet 'n program van twee, maar verkieslik drie toedienings (twee maande uitmekaar) insluit. Let op residu-weerhoudingstydperke van aalwurmdoders en lees die etikette van die verskillende produkte deeglik.

Wortel en kraagvrot

Phytophthora-wortel- en kraagvrot-beheerprogramme in die Wes-Kaap kan in die herfs begin. Ridomil-wortelsonebehandeling (2.1 ml/m²) en fosfonaatblaarbespuitings kan gebruik word. Drie fosfonaattoedienings (twee maande uitmekaar) behoort gedoen te word. Let op weerhoudingstydperke.

Baie belangrik: Lees die etikette van die verskillende produkte deeglik, veral die waarskuwings. Vermyn die gebruik van die fosfonate indien toestande voorkom wat bome onder enige vorm van stremming plaas. Bo en behalwe droogte en hitte, kan bergwindtoestande ook bome onder tydelike verwelkte toestande plaas wat 'n gevaar inhou vir blaarbespuitings. Bome moet dus nie tydens, of kort na sulke toestande gespuit word nie. Laastens beïnvloed drag ook 'n boom se gevoeligheid vir droogtespanning. Hoe hoër die drag, hoe gevoeliger is die boom vir uitdroging en hoe groter is die risiko vir fitotoksisiteit.

Bruinvrot

Herfsreëns kan tot ernstige na-oesbederfverliese deur *Phytophthora*-bruinvrot lei. 'n Enkele vrug wat met bruinvrot besmet is, kan tydens verskeping die res van die vrugte in 'n uitvoerkarton besmet.

In die somerreënvalgebiede word bruinvrot deur die patogeen *Phytophthora nicotianae* veroorsaak, en affekteer dit

vrugte op die onderste 1.5 m van die boom naaste aan die grondoppervlak. Dit behoort dus redelik veilig te wees om slegs hierdie onderste band vrugte te spuit in boorde waar die *Phytophthora*-voorkoms nie hoog is nie. In die winterreënvalgebiede kom *Phytophthora citrophthora* ook voor. Hierdie patogeen versprei hoër op in die boom en kan vrugte tot bo in 'n sitrusboom besmet. Die totale blaar-oppervlak in hierdie streke moet gespuit word. Bruinvrot ontwikkel slegs wanneer die klimaatstoestande gunstig is vir die patogeen (*Phytophthora*) om te infekteer en te ontwikkel. Indien dit 'n droë najaar is en geen of ligte reënuitjies kom voor, is voorkomende bespuitings nie nodig nie. Indien dit 'n nat winter of najaar is, moet bome gespuit word. Kontakswamdoders soos byvoorbeeld koper (200 g/100 l) of mankoseb (200 g/100 l) kan gespuit word om bruinvrot te beheer. Daar is egter beperkinge t.o.v. mankoseb vir sekere markte. Beide hierdie produkte is slegs kontakmiddels en dit kan deur reën en besproeiing afgewas word. Daar is ook 'n gevaar dat indien die kopertoedienings en proteïenvrugtevlieglokase te na aan mekaar toegedien word, fitotoksisiteit ("stippeling") op die skille kan voorkom. Hierdie gevaar is hoër tydens kleurbreek. Sistemiese fosfonaatwammiddels is uiters effektief vir die beheer van bruinvrot: Verskeie fosfonate is geregistreer vir die gebruik teen bruinvrot. Raadpleeg etikette waar nodig om te bepaal watter produkte hiervoor geregistreer is. Die fosfonate is ook effektief teen bruinvrot indien dit in 'n wortelvrotprogram as 'n blaarbespuiting gebruik word. Geeneen van die fosfonaatstam-aanwendings is effektief teen bruinvrot nie.

Waterbestuur/water management (P. Raath)

Besproeiingskedulering/Irrigation scheduling

Mature citrus trees require between 7 000 and 10 000 m³ water p/ha p/a. Water is lost through evaporation, run-off, leaching

and transpiration. Transpiration, and in some instances leaching, are beneficial to the trees and therefore, not viewed as a loss. However, non-beneficial losses should be kept to a minimum. Evaporation is largely determined by climatic factors such as radiation, temperature, relative humidity and wind. Run-off is determined by infiltration rate, slope and application rate. Non-beneficial leaching occurs when water penetrates beyond the root zone.

Evaporasie kan verminder word deur te verseker dat druplyne bo-op riwwe vasgemaak is om te verhoed dat water teen die kante van die riwwe afloop. Sodoende word die oppervlakte verminder waarvandaan water kan verdamp. Die grondoppervlak kan ook met organiese materiaal bedek word om verdamping te verminder. Afloop kan verder beperk word deur seker te maak dat die toedieningstempo van die besproeiingswater nie hoër as die infiltrasietempo van die grond is nie. Die periode van besproeiing moet genoegsaam wees om die wortelsone tot veldkapasiteit te benat sonder om die wortelsone te versadig en sodoende oormaat logging of afloop te veroorsaak. Die instandhouding van besproeiingstoerusting is belangrik om te verseker dat die toerusting in 'n goeie toestand is, en dat daar geen lekkasies is nie.

The difference between field capacity and the actual soil water content is called the "soil water depletion". Irrigation timing and the amount of water to be applied are determined by monitoring or estimating soil water depletion and applying water when the depletion reaches a pre-selected level, called the management of allowable depletion.

Grondvogsensors wat die grondwaterinhoud meet in kombinasie met veldobservasies (voeltoetse) is 'n beter aanduiding vir "wanneer" en "hoeveel" besproei moet word, as die uitsluitlike gebruik van gewasfaktore (of die sogenaamde kalendermetode) waar besproeiing op 'n voorafbepaalde tyd plaasvind, bv. elke Dinsdag en Vrydag.

Tensiometers

Tensiometers are installed in pairs. The ceramic cup of the first tensiometer must be in the root zone and the second cup should be below the root zone. For most soils the reading should be between -5 and -20 kPa at field water capacity. No tensiometer should remain on zero or even at -5 kPa for too long, as this is an indication of water-saturated conditions. As the soil dries out, the tension slowly increases (readings become more



negative) until a certain inflection point is reached. This point is characteristic of the soil and lies between -30 and -70 kPa. The tension increases rapidly after the inflection point has been reached.

For sandy soils, irrigation should probably commence at a tension of -30 kPa, and in clay soil at -40 to -50 kPa. However, it is important to note that these values are characteristic of the soil and should be determined for each irrigation block.

Irrigation is scheduled according to the readings of the shallow tensiometer. The deeper-placed tensiometer monitors over- and under-irrigation. If the deeper-placed tensiometer continuously gives a low reading then over-irrigation is indicated. However, if it gives increasingly higher readings despite irrigation, it indicates under-irrigation. Make sure to calibrate the tensiometer readings with field observations in the root zone and below the root zone.

Kapasitans "probes"

Kapasitans "probes" meet op verskillende dieptes die relatiewe waterinhoud van die grond. Hierdie metings geskied op 'n kontinue basis (elke 30 of 60 minute). Die sagteware maak voorsiening dat 'n versadigingspunt, 'n hervulpunt en droë punt geselekteer kan word. Indien die grafiek tot by die hervulpunt daal, kan met besproeiing begin word. In gronde met 'n hoë klei-inhoud is dit moeiliker om die verandering in die waterinhoud van die grond waar te neem.

Profielput

'n Profielput in die wortelsone van die bome kan weekliks of selfs tweewekliks gegrawe word. Die waterinhoud van die grond word dan visueel waargeneem en die besproeiingskedulering word daarvolgens beplan. Die voordeel van hierdie metode is dat probleem-areas geïdentifiseer en geïnspekteer kan word.



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MC Pretorius

Postharvest pathology - waste prevention checklist (C. Savage, L. Mamba and W. du Plooy)

The origin of decay

All the postharvest citrus diseases are present in the orchard. Around 1% of the fruit harvested will have established green mould or sour rot infections; this needs to be dealt with swiftly by the packhouse. The packhouse needs to convey the importance of the following practices to the orchard management:

- sanitation to minimise the inoculum (spore) load in the orchard
- establishing protocols to minimise wounding of fruit during harvesting; prevention of wounds will dramatically reduce the incidence of infections
- optimising FCM and fruit fly control to

- minimise wounds and risk of decay
- treating the fruit within 24 hours of harvesting; this will enable the postharvest fungicide/s to curatively control established infections.

The packhouse can make or break it

The time taken from the tipping of fruit to wax application is short and every single process must be managed diligently to reduce the risk of waste.

Chlorine treatment

- Measure ORP – it should be ± 800 mV
- If ORP is too low, adjust pH and concentration
- pH should be 6.5 - 7.5
- Concentration should be 75 - 100 ppm (active chlorine) or 100 - 200 ppm (total chlorine).
- The concentration needs to be monitored continuously; an automatic dosing system is highly recommended.

Pre-packhouse drench

- The CRI factsheets list all the recommended fungicide options for the pre-packhouse drench and need to be consulted. The factsheets are available to members on the CRI website.
- It is imperative to have adequate water flow in order to have all the fruit in all the bins drenched thoroughly – drenches must deliver at least 250 l drench mixture/bin/min.
- Pre-suspend fungicides in warm water and add to the tank while agitating, remembering to use the order SC > EC > SL. Then fill the tank to the correct level.
- Exposure time is 1 - 3 minutes.
- Replace mixture after 150 bins (1 000 l tank), or 200 bins (2 000 l tank), or 300 bins (3 000 l tank).
- Constant agitation.
 - the system must be in operation for at least 15 minutes before use
 - never let the fungicide mixture stand still, as the chemicals will settle out and be unavailable for treating the fruit.

Fungicide dip tank and in-line drench

- The fungicide of choice for use in the aqueous applications is imazalil sulphate for all markets. No market restrictions are predicted for the immediate future, although CRI is investigating alternatives.
- The imazalil sulphate concentration should be managed continuously by means of titration and maintained at 500 ppm.
- The pH level of imazalil solution should be kept stable to ensure consistency in terms of residue loading. An automatic dosing system for pH is recommended:
 - pH 3 will result in lower residue levels (around 1 ppm), but can still give excellent curative control if exposure time is 60 - 90 seconds, and fruit is treated within 24 hours of infection.
 - pH 6 will result in higher residue levels (around 2 - 3 ppm), but the exposure time needs to be limited to 45 seconds to prevent maximum residue level (MRL) exceedance.
- The CRI factsheets list all possible options for the fungicide bath or in-line drench, and need to be consulted.
- If not replaced on a daily basis, the fungicide solution should be pasteurised every evening by increasing the temperature to no less than 60°C. Keep it there for 20 minutes and let the solution cool down overnight.

Wax application

- Fruit should be dry when entering the wax applicator – wet fruit will hamper the efficacy of this treatment.
- It is highly recommended to apply imazalil in the dip tank and thereafter in the wax. The wax application will ensure good protective control and sporulation inhibition of green mould, while the aqueous application provides excellent curative control.
- Wax containers/tanks containing fungicides should be gently agitated continuously (i.e. 24 hours a day, seven days a week) to ensure that

thiabendazole and imazalil stay in solution, and do not precipitate.

Precipitated chemicals will result in MRL exceedance from wax lower down in the container, while the top layers will not have enough residue to give the desired protection. Containers should also be tightly sealed to prevent the wax formulation from deteriorating.

- Do not use air bubbles as an agitation measure as they break down the wax formulation due to liberation of the volatiles and oxidation of the solvent system.
- Do not over-agitate the wax, as this also eliminates the volatiles that are an integral part of the wax during film formation after application.
- Ensure that fruit is totally and uniformly



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covered in wax; if not, contact your wax suppliers for support.

- Ensure that wind from the drying tunnel is not blowing back onto the wax applicator. This will cause wax to dry on the last brushes, causing hardening of the bristles. Such hardened bristles are ineffective in wax application and could cause injury to the fruit rind. It is also a waste of wax and fungicides.
- #### Cold chain
- Fruit should be placed under cold storage as soon as possible.
 - Maintaining the cold chain will reduce the incidence of green mould infections and physiological rind disorders.
 - Never break the cold chain.

Sanitation

- Packhouse sanitation is all about keeping inoculum (spore) levels as close to zero as possible.
- No fruit should be present on the floor, and no waste fruit should be around (not even in bins), but should be removed immediately. Also:
 - Remove any waste fruit from the packhouse and discard in closed containers as soon as possible.
 - Do not allow fruit destined for the juice factory to be anywhere near your packhouse.
- Sanitation is an effective way of preventing fungicide resistance from developing.

Remember

Fresh citrus fruit is a high-risk, perishable commodity. The fruit is alive and therefore respiring, and the shelf life and quality need to be maintained. The packed export crop must be moved from the packhouse into the cold chain as soon as possible, thereby reducing the risk of loss of quality and waste. ▶